

## Effect of Genotypes on Soyabean Seed Quality Development under West African Rainfed Conditions

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### ABSTRAK

Pemantauan telah dijalankan terhadap kesan genotip ke atas perkembangan kualiti biji benih kacang soya ketika musim hujan di Abeokuta antara Julai dan November 1997. Peningkatan berterusan dalam kadar percambahan normal dan kemunculan anak benih berlaku di awal penuaian. Kadar percambahan yang paling banyak, dikesan pada biji benih yang dituai pada peringkat-peringkat kematangan fisiologi (fungsi) dan penuaian (penuh). Secara signifikan, kemunculan anak benih dipengaruhi oleh tarikh penuaian biji benih kacang soya. Percambahan dan kemunculan meningkat semasa dalam proses perkembangan biji benih kacang soya, dan yang paling banyak ialah bagi biji benih yang dituai antara R7 dengan R8 dalam kesemua kultivar kacang soya. Pengerangan kepada kandungan kelembapan 10% menggalakkan percambahan biji benih yang dituai di sekitar peringkat-peringkat kematangan fisiologi. Permulaan pengerangan adalah antara peringkat-peringkat kematangan fisiologi dan penuaian dalam keenam-enam kultivar kacang soya. Kemerosotan secara mengejut kemunculan anak benih kering tiruan pada 50d selepas mtff seolah-olah bertentangan dengan 60d selepas mtff bagi percambahan biasa di makmal. Keadaan menunjukkan bahawa biji benih dari percambahan yang baik tidak semestinya menghasilkan anak benih di bawah keadaan pertumbuhan yang baik kerana genotip adalah berbeza-beza. Cantuman sifat-sifat biji benih seperti saiz, berat, kebolehcambahan dan keupayaan tumbuh sangat penting dalam pembiakbakaan kacang soya. Hal ini memudahkan pemilihan genotip dengan kualiti biji benih yang baik. Dengan itu juga mengurangkan kaedah perlindungan dan penyimpanan yang berlarutan.

### ABSTRACT

Effect of genotypes on soyabean seed quality development was monitored under rainfed conditions at Abeokuta between July and November, 1997. A consistent increase in rate of normal germination and seedling emergence occurred among early harvests. Greatest germination rate was detected in seeds harvested around physiological (functional) and harvest (full) maturity stages. Seedling emergence was significantly influenced by seed harvest date in all soyabean entries. Germination and emergence increased as soyabean seed development progressed and was greatest for seeds harvested between R7 and R8 in all soyabean cultivars. Enforced desiccation to 10% moisture content promoted germination of seeds harvested around physiological maturity stages. The onset of desiccation tolerance fell between physiological and harvest maturity stages in all the six soyabean cultivars. The rapid decline in seedling emergence of artificially dried seeds at 50d after mtff as against 60d after mtff for normal laboratory germination indicated that seedlots of initial good germination may not necessarily produce high seedling emergence under good seeding condition due to differences in genotypes. Association of seed characters such as seed size, seed weight, germinability and emergence ability is essential in soyabean breeding to facilitate selection of genotypes with good seed quality, thereby reducing elaborate storage and screening methods.

### INTRODUCTION

Soyabean (*Glycine max* (L.) Merrill) is a leguminous crop which has attracted active research recently in Africa. Soyabean was introduced into Tanzania in 1907, Nigeria in 1908 and Uganda

in 1913. The leading soyabean producers in the continent include Nigeria, Egypt, Zambia, Zimbabwe and South Africa (Grumisiriza 1987). The nutritional values of whole soyabean seeds and soyabean meal are of great importance to man

and livestock. The composition of soyabean at harvest is as follows: 14 – 16% moisture, 40% protein, 20% oils and 35% carbohydrate (Anon 1987).

Soyabean can suffer considerable deterioration before harvest (Green *et al.* 1965; Tekrony *et al.* 1980a, b) as well as during and immediately after harvest (Green *et al.* 1966; Ojo 2000). Warm temperatures and high relative humidity in particular, make the subsequent maintenance of soyabean seed viability during storage difficult (Delouche 1974; IITA 1977; Ajala and Adebisi 1999). Mean air temperature, mean relative humidity and precipitation per day have been reported to have a high negative correlation with vigour. Thus, seed deterioration on mother plants in the field can be influenced by the same environment factors causing deterioration in storage (Tekrony *et al.* 1980a).

Several investigations have emphasized the need for prompt harvesting of the soyabean crop (Green *et al.* 1966; Delouche 1974). Harvest maturity which corresponds to the time the seeds dry to a moisture content of 41 to 15% has been suggested (Delouche 1974; Tekrony *et al.* 1980b; Ojo 2000). Serious field deterioration of soyabean seeds before and after harvest maturity has also been associated with increased incidence of seed borne fungal (*Phomopsis* sp) infection (Tekrony *et al.* 1984).

Delayed harvesting in soyabeans not only increases the rate of disease infection in the field (Tedia 1976), but results in embryo destruction (Moore 1971), lower seed germination and seed quality, and increases seed susceptibility to mechanical damage (Green *et al.* 1966).

The principal objective of this study was to examine the effect of genotypes on changes in seed quality of the mother plant during seed development and maturation. It was specifically intended to further distinguish between seedlots of high germinability. Result of the experiment would help (a) to clarify the best time West African soyabean producers should harvest their soyabeans in order to obtain high quality seeds, and (b) to advise soyabean breeders and agronomists on appropriate procedures for the selection of soyabean genotypes with potentially good emergence ability especially under humid West Africa field conditions.

## MATERIALS AND METHODS

Effects of genotypes on soyabean seed quality development were monitored under rainfed conditions at Abeokuta, Nigeria between July and November, 1997. Normal laboratory germination and seedling emergence test were used as criteria for seed quality assessment. Following land preparation, 125 kgN/ha, 137kgP/ha and 125kgK/ha were applied in the form of compound fertilizer: N.P.K. 15:15:15 and single superphosphate. Soil samples were ground and sieved with 2mm and 0.5 mm sieves. The particle size, percentage nitrogen (N), phosphorus (P), and potassium (K) and the soil type were determined in the soil analytical laboratory at IITA, Ibadan, Nigeria.

Each of the six soyabean genotypes was sown in non-replicated 10 row plots with inter-row spacing of 75cm. Each row was 10m long and distance within row was 5 cm. Pre-emergence herbicide mixture of Galex (metobromuron + metolaclor) and Gramoxone (paraquat dichloride) in a CP3 knapsack sprayer at the rate of 5 and 3 litres per hectare respectively, were applied immediately after sowing.

Ten sequential harvest of pods from the middle eight rows of each plot were made at 5d intervals commencing from 30 – 40d after mean time to first flower depending on genotypes (R5) to a further 10d after full maturity stage (R8) (Fehr and Caviness 1977). Enough pods were harvested fresh and threshed by hand to obtain a seedlot of about 1,200 seeds from each soyabean genotype at each harvest.

Each seedlot was divided into two halves. The first half (600 seeds) was further divided into two sublots. Each subplot with 300 seeds was needed for the standard laboratory germination (Bp) tests (ISTA 1985a) and emergence test in sandy soil, i.e. for every sequential harvest, three replicates of 100 freshly-harvested seeds were needed for each of the laboratory and emergence test.

A second half of each of the original seedlot was dried artificially to about 10% moisture content in an air-conditioned room maintained at about 22°C and 45% relative humidity with two sorption – type air dehumidifier (Ellis *et al.* 1985). A rotary fan was used to ensure air circulation. Viability of dried soyabean seeds was also determined by standard germination tests (ISTA 1985b) and emergence tests were conducted in

sandy soil in a manner similar to the freshly harvested seeds mentioned.

## RESULTS

Table 1 presents the seed dry weight, time from sowing to first flower, maturity days and 100 seed-weight of six soyabean genotypes evaluated. All genotypes except TGX536-02D, TGX849-313D and TGX923-2E were significantly different from each other for seed dry weight. The time from sowing to first flower showed that TGX536-02D and TGX923-24 were different from other genotypes with reduced days to flowering (39d and 40d respectively), while TGX923-2E recorded highest days to flowering (48d). The six varieties were different from each other for maturity days and 100 seed-weight.

TABLE 1

Seed dry weight, time from sowing to first flower, maturity days and 100-seed weight of six soyabean genotypes sown under rainfed conditions at Abeokuta in July, 1977 and harvested in November, 1997

Genotypes	sdw (mg/seed)	tff (days)	Seed maturity (days)	100-seed weight at 10% M.C. (mg)
Bossier	165.0	39	102	166
737p	113.3	40	99	115
TGX536-02D	121.7	43	107	121
TGX849-313D	126.7	46	109	135
TGX1448-2E	141.7	45	116	131
TGX923-2E	123.3	48	119	120
LSD (0.05)	8.1	1.2	0.99	0.30

Sdw = seed dry weight

Tff = time from sowing to first flower

Mc = moisture content

The quality of freshly-harvested seeds of soyabean genotypes Bossier, 737p, TGX536-02D and TGX849-313D (Fig. 1) started to show improvement in normal laboratory germination from about 35d after mtf. Seed quality was maximal (95-98%), at around mass maturity stage (R8) and subsequently declined. For genotype TGX923-2E, however, improvement in seed quality as indicated by percentage germination of freshly-harvested seeds commenced between R5 and R6 and was maximal (82-88%), between R7 and R8 reproductive stages and thereafter declined (Fig. 1). Deterioration and rate of de-

cline in quality of freshly-harvested seeds after the R8 stage was more drastic in genotypes Bossier and TGX1448-2E than the other four genotypes (Fig. 1).

Normal germination of mature artificially-dried seeds of all six genotypes improved progressively and was maximal (55-90%) between R7 and R8 stages followed by a rapid decline to about 31% for Bossier and 0% for TGX1448-2E (Fig. 1). Effect of rapid artificial drying on genotype 737p, however, was not as devastating, as percentage normal germination dropped from a peak of 88% at around R8 stage to about 75% some 10d after harvest maturity (Fig. 1). Decline in normal germination started about 60d after mtf for freshly-harvested seeds in all genotypes. However, genotype 737p appeared to be desiccation tolerant when compared with the other five genotypes (Fig. 1).

Enforced desiccation to 10% moisture content had a lethal effect on green immature seeds rather than promoting germination of seeds harvested at around physiological maturity (R7 stage). The onset of desiccation tolerant, a period after which seeds survive enforced desiccation on removal from the mother plant and the timing of peak seed quality (Pietafilho and Ellis 1991) fell between physiological maturity and harvest maturity stages in all six soyabean genotypes in this study (Figs. 1 and 2).

Seeding emergence was significantly influenced by seed harvest date in all soyabean entries. The ability of seeds to germinate and emerge from sandy soil increased as soyabean seeds developed and was greatest for seeds harvested between R7 and R8 reproductive stages in all six genotypes. For instance, soyabean seeds harvested fresh between R7 and R8 growth stages produced maximum seedling emergence of between 90 and 96% for all genotypes except TGX849-313D and TGX1448-2E, with 80 and 48% emergence, respectively (Fig. 2).

However, it was observed in this study that rapid artificial drying did not have any significant effect on seedling emergence of genotypes Bossier, 737p and TGX536-02, whereas it significantly improved seedling emergence (76-81%) of genotypes TGX849-313D, TGX1448-2E and TGX923-2E especially for seeds harvested after R7 reproductive stage (Fig. 2).

In the six genotypes, however, green seeds harvested between R5 and early R7 stages suffered severe desiccation after rapid artificial dry-

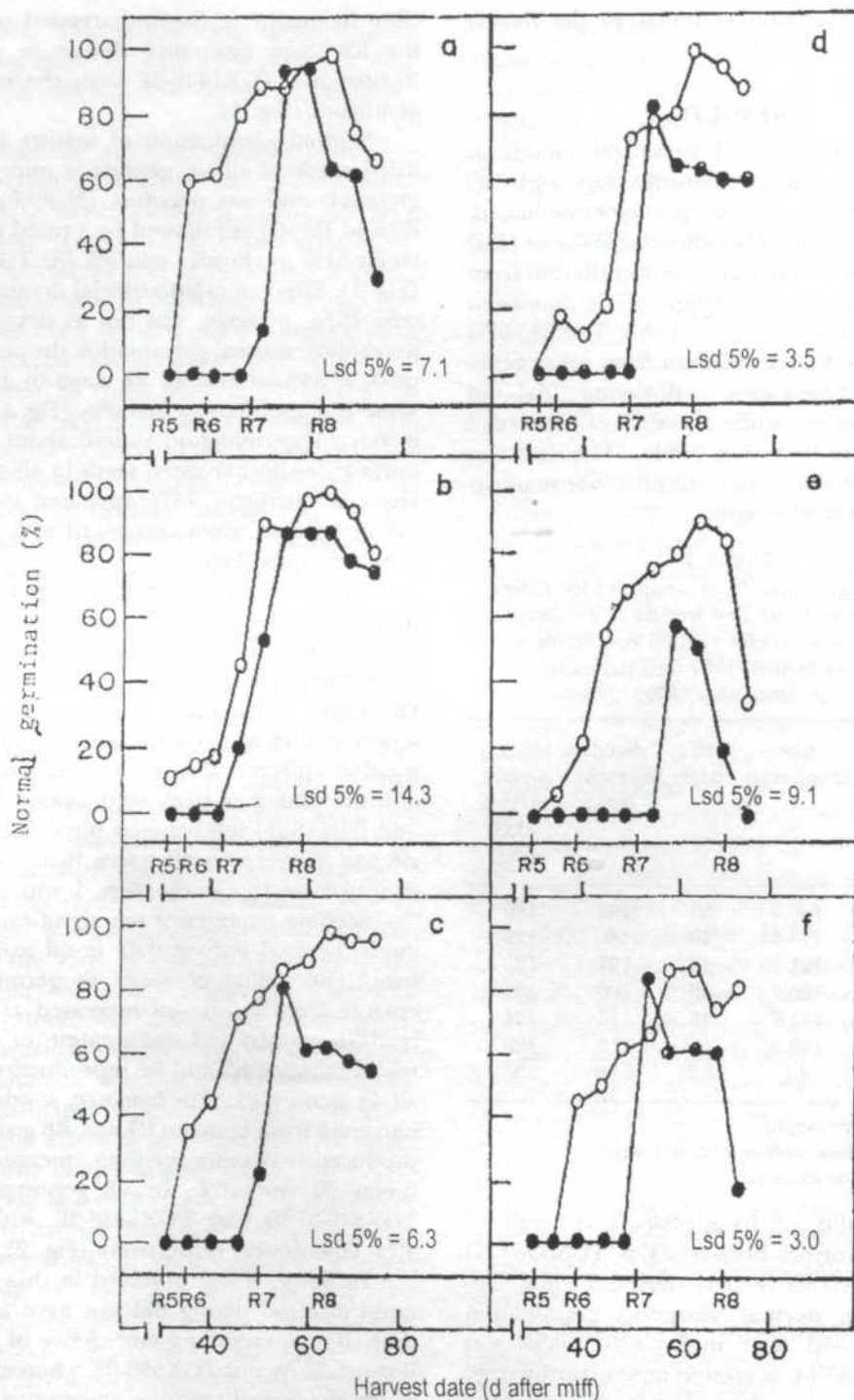


Fig. 1. Normal germination (%) of freshly-harvested (open circles) and artificially-dried (to 9–11% moisture content, f.wt. Basis) (solid circle) seeds of cus Bossiar (a) 737p (b) TGx 536-02D (c) TGx 849-313D (d) TGx 1448-2E (e) and TGx 923-2E (f) Under rainfed conditions in 1997, in relation to harvest time (d after mttf). Growth stages (R5-R8) which correspond to harvest dates are shown

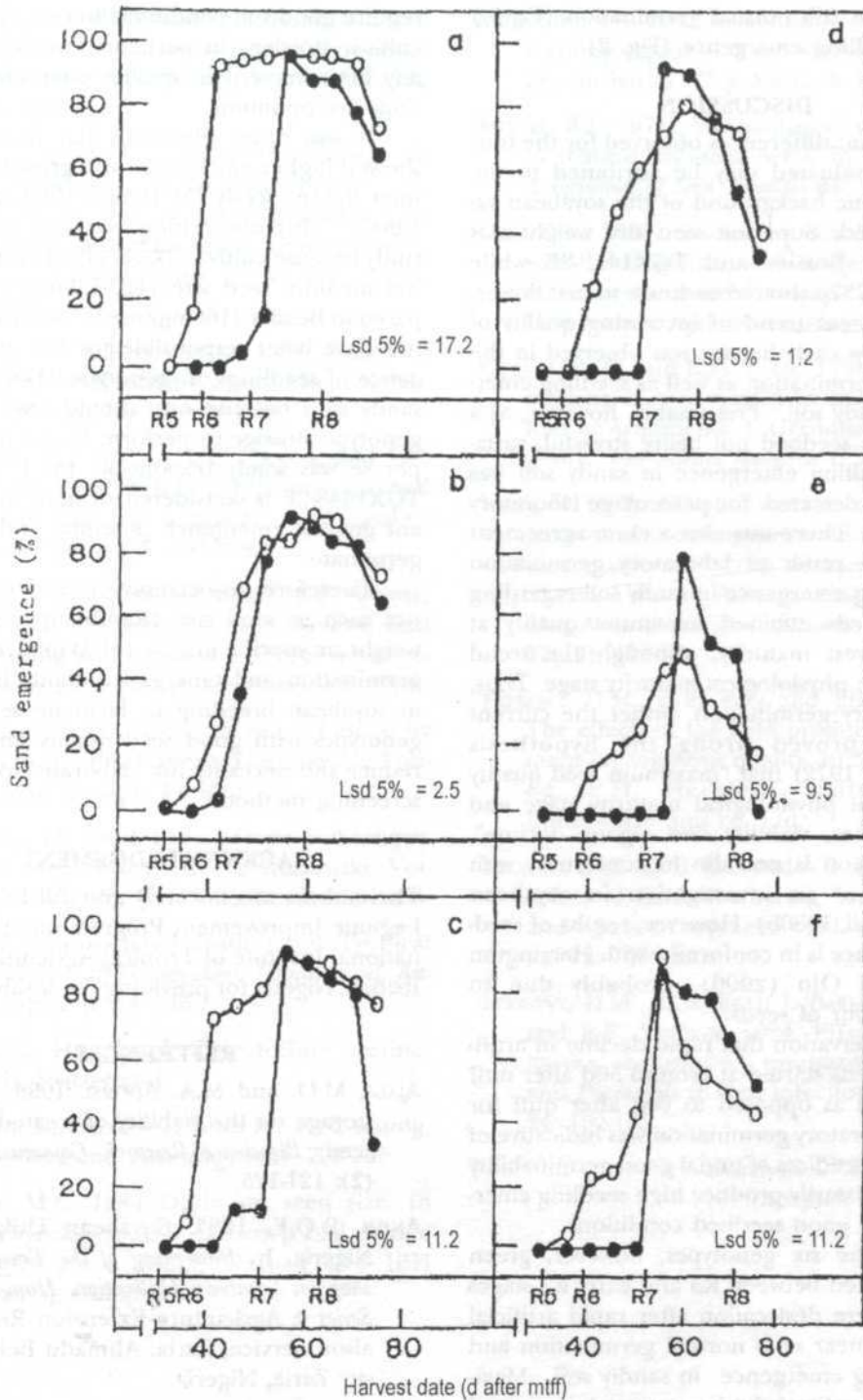


Fig. 2. Seedling emergence (%) in sand soil of freshly-harvested (open circles) and artificially-dried (to 9-11% moisture content, f.wt. Basis) (solid circles) seeds of *cus Bossier* (a) 737p (b) TGx 536-02D (c) TGx 849-313D (d) TGx 1448-2E (e) and TGx 923-2E (f) Under rainfed conditions in 1997, in relation to harvest time (d after mttf). Growth stages (R5-R8) which correspond to harvest dates are shown.

ing with near 0% normal germination (Fig.1 ) and 0% seedling emergence (Fig. 2).

### DISCUSSION

The significant differences observed for the four characters evaluated may be attributed to the diverse genetic background of the soyabean varieties studied. Superior seed dry weight was observed in Bossier and TGX1448-2E while Bossier and 737p showed earliness to first flower.

A consistent trend of increasing quality of seeds among early harvest was observed in the laboratory germination as well as seedling emergence in sandy soil. Presumably, however, as a result of the seedbed not being stressful, variations in seedling emergence in sandy soil was close to that detected for percentage laboratory germination. There was also a close agreement between the result of laboratory germination and seedling emergence in sandy soil regarding the time seeds attained maximum quality at around harvest maturity, although the trend started at the physiological maturity stage. Thus, the laboratory germination, under the current study has proved wrong the hypothesis (Harrington 1972) that "maximum seed quality is attained at physiological maturity stage and that thereafter, viability and vigour decline". This conclusion is not also in conformity with the results of an investigation in soyabean (Tekrony *et al.* 1980b). However, results of seedling emergence is in conformity with Harrington (1972) and Ojo (2000), probably due to reduced vigour of seeds.

The observation that rapid decline in artificial-dried seeds started at around 50d after mttf in sandy soil as opposed to 60d after mttf for normal laboratory germination was indicative of the fact that seedlots of initial good germinability may not necessarily produce high seedling emergence under good seedbed conditions.

In all the six genotypes, however, green seeds harvested between R5 and early R7 stages suffered severe desiccation after rapid artificial drying with near zero normal germination and zero seedling emergence in sandy soil. Maximum seed quality (whether assessed as normal germination ability or emergence ability) was attained at around harvest maturity stages and subsequently declined. The reason for the unexpected observations might be genetic, because some genotypes such as 737p and TGX849-313D

require good soil conditions to do well, whereas cultivar Bossier in particular would not show any improvement in quality even when conditions are optimum.

It was often observed that heavier seeds showed higher emergence and growth potential than lighter seeds (McDaniel 1969; Kaufmann 1984). This observation was not true in this study because cultivar TGX1448-2E, for instance, has medium seed size (120-135mg/seed) compared to Bossier (166mg/seed). Seed size should not have been responsible for the good emergence of seedlings of genotype TGX1448-2E in sandy soils because one should have expected genotype Bossier to perform better if seed size per se was solely responsible for it. Genotype TGX1448-2E is considered to have some inherent genetic emergence potential and ability to germinate.

Therefore, association of seed characteristics such as seed size (Kaufmann 1984), seed weight or specific gravity (McDaniel 1969) with germination and emergence ability is essential in soyabean breeding to facilitate selection of genotypes with good seed quality and thereby reduce the necessity for elaborate storage and screening methods.

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